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ABSTRACT

This paper reviews three studies which examine cognitive processes and brain electrical activity in gifted children. The studies concentrated on mathematically gifted children and/or their sleep patterns. All three studies used the interhemispheric electroencephalogram to examine the gifted child's ability to harness right hemisphere capacities and bring them to bear in intellectual situations. Settings varied from memory representation of faces and world data tests to the use of cognitive skills required to produce dreams. In the sleep studies, the recall of substantive material from REM (rapid eye movement) sleep arousals varied positively with IQ level. But the difference between working and sleep hemispheric ratios was a greater equalization of hemispheric activities during sleep instead of the expected increase in the right hemisphere. The main difference between children with superior IQs and normal controls was that the gifted children slept longer. In the cognitive skills tests during the natural cognitive state at the baseline level, the mathematically talented subjects showed more activation in the left hemisphere than the right hemisphere, suggesting that the right hemisphere of the intellectually precocious child does not become more actively engaged during cognitive processing. (Contains 15 references.) (DB)

Running head: Gifted

The Mind/Brain Relationship of the Gifted Child

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Abstract

Researchers have wondered about the physical properties of intelligence for many years. Work has been done to determine the mind/brain relationship in gifted children by various teams. In this paper, studies of the interhemispheric electroencephalogram changes in gifted children are explored. The studies concentrate on mathematically gifted children and /or their sleep patterns compared to those of normal children. The conclusions lead to more questions as good research does.

The Mind/Brain Relationship of the Gifted Child

Introduction:

A precocious child tosses in her sleep as she experiences a dream. Across town, her friend who is of average intelligence, also tosses as she dreams. But are their brains functioning similarly? One student mentally whizzes through the math problem like a skater on ice while his friend beside him struggles with the first step of the problem. But what is going on in those two brains?

Educators use IQ levels to classify students for gifted programs, but the professional still knows little of exactly what causes the differences. Teachers can see the outward results in student's work, yet they do not understand why it happens. Researchers work to answer these questions. Assumptions such as normal cognitive development and functioning depended on normal physiological maturation are being tested and researched. Yet discrete physiological correlates of cognitive functioning remain elusive (Busby & Pivik, 1983). The difference between brain functions of the gifted child compared to the average child is still a challenge to be unraveled. Jackson's "sleep cognition hypothesis" explained an association between different types of cognitive deficit and sleep patterns (Grubar, 1985). This hypothesis establishes a relationship between physiological activity waking memory and learning processes. Mental retarded children showed less rapid eye movement(REM) sleep, longer REM latencies and more frequent waking arousal than the normal controls.

Some progress is being made. Over the last half century, researchers established some norming data of properties of electrical brain activity using electroencephalograms.

Using this norming data, research has been done to pin down differences in particular circumstances. Using mathematically precocious children, a group at Iowa State University investigated for enhanced right hemisphere activation (O' Boyle, Alexander & Benbow, 1991).

In 1989, large individual differences in human information processing abilities and propensities were established through studies of relationships between patterns of hemispheric specialization and cognitive functioning (O' Boyle & Heelige, 1989). It was further determined that intellectual ability differences may be related to the degree and/or direction of hemispheric dominance patterns. There was even a small, but reliable deficit for lefthanders on tests of spatial ability (Levy, 1969).

During the research on the mathematically gifted children, alpha activity at four brain sites (frontal, temporal, parietal, and occipital lobes) over the left and right cerebral hemispheres was monitored while the test groups of 12 to 14 years old, right-handed males: (a) examined a blank slide (this was done to establish a baseline condition, (b) determined which of two chimeric faces was "happier," and (c) decide if a word was a noun or a verb.

Based on previous research of Benbow, correlating intellectual giftedness to soft neurological signs of enhanced right cerebral hemispheres(RH) predicated that the activation level of the RH would be higher in the precocious than in the average math ability subjects. (Benbow, 1986). If this occurred, it would agree with the hypothesis that unusually active RH correlates with intellectual precocity.

Two predictions were made concerning the chimeric face task. On a behavioral level, it was predicted that the gifted and the average ability subjects would show a leftward/RH bias.

They would choose the left side smile/right side neutral face composites as being happier. On the electrophsiological level, the hypothesis was that both groups would show a marked reduction in RH alpha power. However, it was believed that the precocious group would have greater RH alpha suppression.

For the word condition segment, both groups were expected to show a left cerebral hemispheres (LH) reduction in alpha power because noun/verb classifications are performed by language faculties located in the LH. In the talented math group, the prediction was that the LH alpha suppression would be less pronounced or bilateral (O' Boyle & Benbow, 1990a).

At baseline, the gifted group obtained greater alpha power all four brain sites over the RH, particularly the temporal lobe. This was opposite of the prediction and pointed to the fact that the LH rather than the RH is more active in mathematically talented during the neutral cognitive state.

The chimeric face test's findings were congruent with the unique link among the RH, the temporal lobe, and the mediation of facial affect (Beaumont, 1983). The composite pattern of results provided evidence at the behavioral and physiological level for enhanced RH activation as a correlate of mathematical precocity.

In the word study, the findings were more ambiguous. A contrasting aspect was a trend toward right parietal lobe activation during non/verb determination for the mathematically gifted subjects. With the studies done to this point, it appears that enhanced RH activation does have some relationships to intellectual precocity. The characteristic may be biologically determined and a gifted individual may have an innate superiority in the fields of accessing, coordination, and implementing the cortical resources of the RH. This supplementary processing power may manifest itself as precocious intellectual ability. The gifted brain's mysteries have begun to unfold, but researchers are still working on the puzzle.

Another aspect of cognitive functioning is being studied by sleep researchers. They have studied interhemispheric electroencephalogram (EEG) changes in the sleep pattern of children of superior intelligence. The hope was to find a difference in comparison to the average child's sleep patterns. With this comparison , some conclusions could be made about functions of the gifted brain.

Researchers have done studies in the elderly and the evidence shows a relationship between intellectual functioning and sleep patterns (Feinberg, Koresko, & Heeler, 1967). Relationships between psychometric scores and some measures of sleep have been studied in mentally retarded and a significant positive relationship between IQ and rapid eye movement (REM)density has been reported (Feinberg, & Carlson, 1968). The next step was to study the relationship between sleep patterns and measured intelligence in children of superior IQ seemed to fall naturally. Researchers felt it would be beneficial to understand the mind/brain relationship during sleep.

As far back as 1925, Terman discovered that precocious children between the ages of seven and 14 slept longer than non-gifted but normal children. (Terman, 1925). Petre-Quadens (1972) conducted a study of the polygraph sleep patterns of children of super intelligence. The test showed reports of higher values for all sleep stages also increased eye movements activity in gifted children as compared to retarded children (Petre-Quadens, 1972). A difference was expected between the sleep patterns of the gifted child and the normal child as well.

Hemispheric EEG activity was again studied looking for the nature of the relationship between brain wave patterns and behavior of the gifted. The cognitive processes were known to have a positive correlation with brain electrical activity so the EEG was used to assess and detect organic pathways of the brain electrical activity in the gifted. Foulkes suggested that specific types of cognitive skills required to produce dreams are analytical skills involving the capability to differentiate and integrate information (Foulkes, Larson, Swanson, & Rardin, 1969).

Pivik's research built on this assumption as they tested adolescents with superior range of intelligence. They chose to work with those adolescents because they had entered the stage of formal operational thought. The children had demonstrated capabilities for integrating information as well as some visa-spatial capabilities as assessed by performances on the Block Design and Embedded Figure tests. The adolescents excelled in cognitive and organizational abilities for dream production and dream complexity (Pivik, Blysma, Busby, & Sawyer, 1982).

The children were monitored and questioned for two consecutive nights. The subjects were asked to describe what they had dreamed and the recall rate was high at 80%. This rate was slightly higher that what Foulkes recorded with IQ's ranging from 91-136 whose recall percentages ranged from 70.9 to 75 respectively.

The recall was of substantive material from rapid eye movement (REM) sleep arousals and varied positively with IQ level (Foulkes, & Kerr, 1969). The difference between the waking and the sleep hemispheric ratios (except the theta activity) were a greater equalization of hemispheric activities during sleep. The results of Pivik's studies did not clear the air, yet they could reflect developmental variations peculiar to adolescence or to the level of intelligence. His group concluded that "the notion of dreaming as a unilateral, right-hemispheric phenomenon, although of heuristic value, provides only a partial fit to the data" (Pivik et al., 1982). The hemispheric specialization of the cognitive processes of the gifted during sleep were proving to be as complex as the same relationships during wakefulness.

Pivik, Blysma, Busby, and Sawyer tried again using male children (8-12 years old) of superior IQ 133.3) and average (IQ 111.0) intelligence. Using standard electrographic measures, they were monitored for five consecutive nights. The brain patterns at different levels of sleep were the main target of this study rather than dream recall. Compared to the normal children, the gifted males had greater amounts of total sleep time (TST), a longer average nonactive rapid eye movement (NREM) cycle length and significantly less than average REM density. There was a negative relationship between full scale IQ and REM density, and between verbal IQ and REM density.

Still the conclusion was that patterns and amounts of sleep stages in superior IQ subjects did not differ significantly from those of children with normal or average IQ.

Yet the results did suggest that some physiological measures may reflect processes underlying the Capability for superior intellectual functioning as determined by IQ measures (Busby, et. al., 1983).

In 1985, another group of gifted and normal children was studied by Grubar (Grubar, 1985). Twenty-three sleep parameters were studied to compare the gifted and normal children. The team found no differences in respect to behavioral and mixed features. They also found no difference in time spent in bed, total sleep time or sleep latency. There was, though considerable differences in electrophysiological parameters that were dichotomized in sleep indices and in eye movements of REM sleep indices.

The total sleep time of both sets of children was similar, but during the course of their sleep, the divisions of the stages and cycles were completely different. The gifted children had several complete sleep cycles although their duration was shortened.

There are more incomplete sleep cycles in normal children than in gifted. A gifted childs REM. sleep periods grew longer and longer during the night. The most apparent difference between the gifted and normal children was their desynchronized sleep, REM and undifferentiated sleep.

The conclusion determined was that high level cognition is clearly associated with special sleep patterns. It is an important step toward the study of intelligence. One day we may know why one student whizzes through math and the other doesn't.

SUMMARY CONCLUSION:

Society agreed that enhanced metacognitive knowledge typifies the mental functioning of gifted children. Researchers agreed that the link between those cognitive processes and brain electrical activity could be the key to understanding the mind/brain relationship of the gifted child.

In this paper, three studies aims at solving the riddle are discussed. The common thread is the use of the interhemispheric electroencephalogram as the basis of the research and the focus on that elusive gifted brain. The studies based their hypothesists on the gifted child's ability to harness RH capacities and bring them to bear in various intellectual situations. The situations in the studies varied from memory representation of faces and word data tests to the use of cognitive skills required to produce dreams. The situations used analytical skills involving the capacity to differentiate and integrate information.

Possible the gifted individual had innate superiority in accessing coordinating and implementing cortical resources of the RH. The researchers, searched for the proof.
The proof was ambiguous. In the sleep studies, the recall of substantive material from REM sleep arousals varied positively with IQ level (Foulkes). Yet the difference between working and sleep hemispheric ratios (except the theta activity) was a greater equalization of hemispheric activities during sleep instead of an increase in the RH. In the cognitive skills tests during the natural cognitive state at the baseline control, the mathematically talented showed more activation in the LH other than the RH.(O ' Boyle). The RH of the intellectually precocious did become more actively engaged during cognitive processing.

In the sleep pattern studies, the data from the superior IQ did not differ dramatically from normal controls except that they sleep longer (Busby). The difference in the stages and cycles of sleep for the gifted may be the result from increased cognition activities during wakefulness (Busby).

The gifted brain produces different results. The researchers hunt after the reason why. One possibility these studies show is that giftedness could suggest the ability to effectively coordinate the LH and RH processing resources. With the electroencephalograph at their side, the researchers plow on in their search for answers.

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